Chapter 3

3.1 A certain fiber has an attenuation of 1.5 dB/ km at 1300 nm. If 0.5 mW of optical power is initially launched into the fiber, what is the power level in microwatts after 8Km?

$$\alpha_{dB/km} = \frac{10}{z} \text{Log}_{10} \left[\frac{P_0}{P_z} \right]$$

$$1.5_{dB/km} = \frac{10}{8_{km}} \text{Log}_{10} \left[\frac{0.5_{mW}}{P_z} \right] \Rightarrow P_z = \frac{0.5\ mW}{10^{1.5 \times 10/8}} = \mathbf{31.6\ \mu W}$$

3.2 An optical signal has lost 55 percent of its power after traversing 3.5 km of fiber. What is the loos in dB/ km of this fiber?

$$P_z = 0.45\ P_0 \Rightarrow \frac{P_0}{P_z} = \frac{1}{0.45}$$

$$\alpha_{dB/km} = \frac{10}{z} \text{Log}_{10} \left[\frac{P_0}{P_z} \right]$$

$$= \frac{10}{3.5_{km}} \text{Log}_{10} \left[\frac{1}{0.45} \right]$$

$$\alpha_{dB/km} \approx 1 dB/km$$

3.3 A continuous 12-km –long optical fiber link has a loss of 1.5 dB/ km:

a) What is the minimum optical power level that must be lunched into the fiber to maintain an optical fiber power level of 0.3 µW at the receiving end?

$$P_0 = P_z * 10^{\alpha.z/10} = 0.3\ \mu W * 10^{(12*1.5\ dB/10)} = 18.9287\ \mu W$$

b) What is the required input power if the fiber has a loss of 2.5 dB /km?

$$P_0 = P_z * 10^{\alpha.z/10} = 0.3\ \mu W * 10^{(12*2.5\ dB/10)} = 300\ \mu W$$

Extra Question

1. A fiber of 100-m length has P_{in} = 10 μ W and P_{out} = 9 μ W. Find the loss in dB/km.

$$\alpha_{dB/km} = \frac{10}{z} \text{Log}_{10} \left[\frac{P_0}{P_z} \right]$$

$$= \frac{10}{0.1_{km}} \text{Log}_{10} \left[\frac{10\ \mu W}{9\ \mu W} \right]$$

$$\alpha_{dB/km} = 4.58\ (dB/km)$$

2. A communication system uses 10 km of fiber that has a 2.5-dB/km loss characteristic. Find the output power if the input power is 400 mW.

$$\alpha_{dB/km} = \frac{10}{z} \text{Log}_{10} \left[\frac{P_0}{P_z} \right]$$

$$P_z = \frac{P_0}{10^{\alpha.z/10}} = \frac{400_{mW}}{10^{2.5 \times 10/10}} = 1.265\ mW$$

3. A 3-km fiber optic system has an input power of 2 mW and a loss characteristic of 2 dB/km. Determine the output power of the fiber optic system.

$$\alpha_{dB/km} = \frac{10}{z} \text{Log}_{10} \left[\frac{P_0}{P_z} \right]$$

$$P_z = \frac{P_0}{10^{\alpha.z/10}} = \frac{2\ mW}{10^{2x3\ /10}} = 0.5\ mW$$

4. What is the maximum core diameter for a fiber if it is to operate in single mode at a wavelength of 1550 nm if the N.A. is 0.12?

$$V = \frac{2\ \pi\ a\ NA}{\lambda}$$

$$a = \frac{V\ \lambda}{2\ \pi\ NA} = \frac{2.405 \times 1550 \times 10^{-9}\ m}{2 \times \pi \times 0.12} = 4\ \mu m$$

$$d_{max} = 2 \times a = 9.9\ \mu m$$